XXIX. *On the Supra-renal, Thymus and Thyroid Bodies.*

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WHILE engaged, two years ago, in observing the structure of the lymphatic glands, my attention was directed to the thymus, thyroid, and supra-renal bodies; and I was led to frame a hypothesis, which, although afterwards requiring some modification, has, I conceive, nevertheless enabled me to detect, if not the real physiological, at least the morphological signification of these apparently anomalous organs.

My hypothesis was, that the thyroid, thymus and supra-renal bodies are the remains of the blastoderma; the thyroid being a portion of the original cellular substance of the germinal membrane grouped around the two principal branches of the omphalo-mesenteric vein; the supra-renal capsules, constituting other portions grouped around the omphalo-mesenteric arteries; and the thymus, the intermediate portion of the same membrane arranged along the sides of the embryonic visceral cavity.

Subsequent observations have satisfied me that this hypothesis is essentially correct, with the exception of that part of it relating to the thyroid, which body I have now ascertained to be a portion of the membrana intermedia of REICHERT, which remains in connection with anastomosing vessels between the first and second aortic arches, or carotid and subclavian arteries.

In the embryo of the Sheep, while the branchial clefts are still open, and for some time afterwards, there is a quantity of blastema arranged in minute lobular masses around the anterior parts of the cardinal veins of RATHKE, surrounding the jugular veins and ductus Cuvieri for a short distance behind the fore-part of the Wolffian bodies. Immediately in front of the Wolffian bodies these lateral masses of blastema are narrow, being scarcely perceptible on the coats of the cardinal veins; but around the ductus Cuvieri they are larger, and differ from the general texture of the embryo, in having a darker colour, in containing no fibres, in separating readily from the surrounding parts, and in their lobulated appearance. They extend forwards nearly to the base of the cranium, and are not connected across the median plain. They are broadest at the sides of the heart, and when the pericardium is opened, are seen through its posterior wall occupying the future situations of the lungs, which at the period stated exist as two small lobulated white bodies, projecting from the intestinal tube, behind and below the heart.

These two lateral masses are the only remaining portions of the membrana intermedia: the posterior portion on each side, on the inner aspect of the anterior extremity of the Wolffian body, becomes the supra-renal capsule; the enlarged middle portion and the outer part of the cervical portion become the thymus; while the internal anterior part resolves itself into the thyroid body. These three organs are therefore at this period continuous with one another on each side of the middle line, no isthmus having yet been formed. They are also continuous with the Wolffian bodies; these bodies, the supra-renal capsule, the thymus and the thyroid forming a continuous mass, situated in the elongated angular channel, which stretches from the cranium to the coccyx on the outside of the intestinal or mesenteric laminæ, and between them and the visceral laminæ.

The Wolffian bodies are the last organs formed out of the membrana intermedia, which assume a special structure. The supra-renal capsules, the thymus and thyroid, retain throughout their existence the original texture of the blastoderma.

Proceeding therefore in the order of formation as well as of position from the Wolffian body, I shall state very briefly what I have observed concerning the mode of development of the supra-renal capsules, thymus and thyroid.

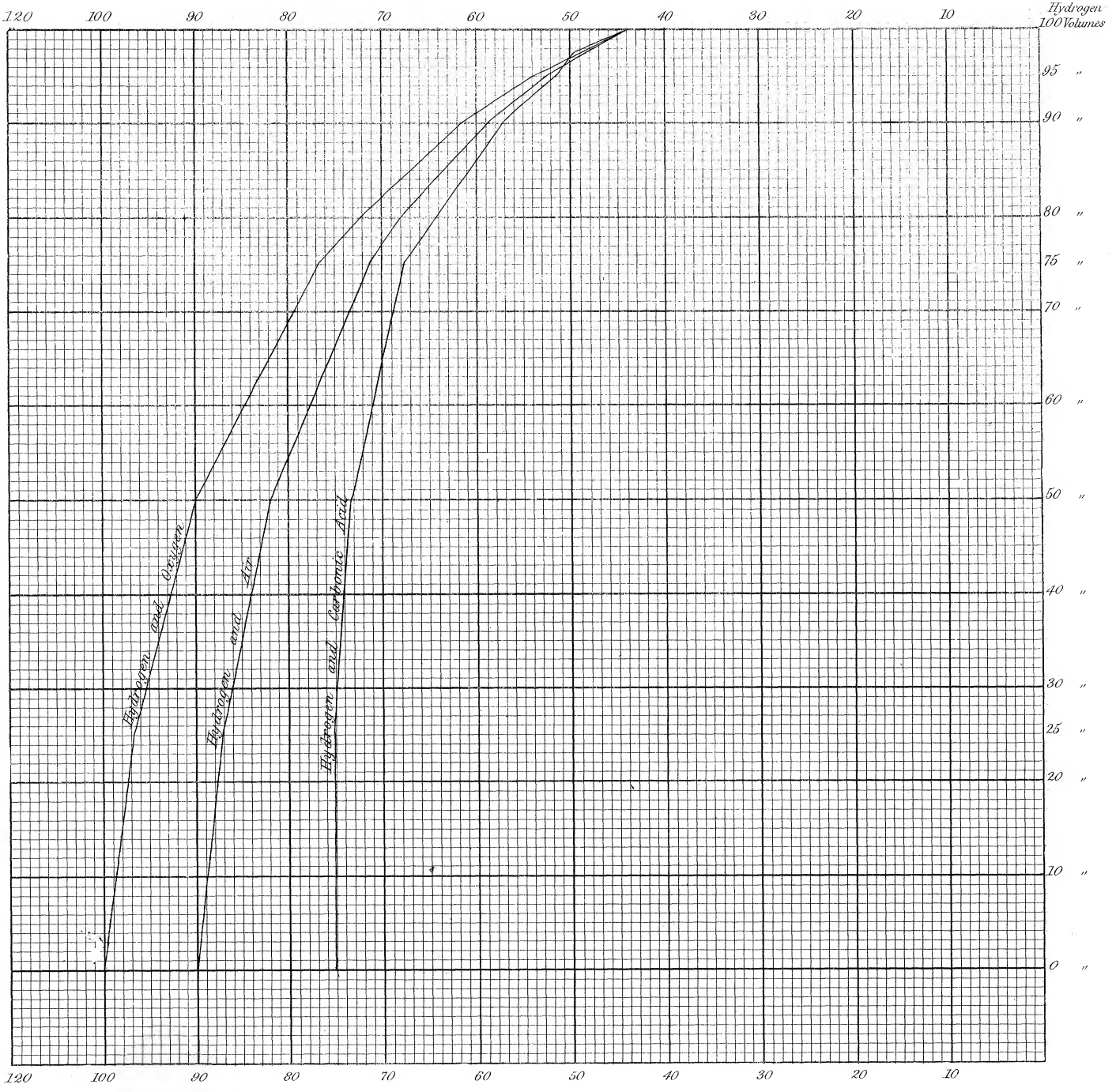
In the embryo of the Sheep, in which the branchial clefts are still quite open, the omphalo-mesenteric vessels well-developed, the liver consisting of an equal-sized lobe on each side of the intestinal tube, the Wolffian bodies well-formed, the allantois beginning to protrude from the abdomen, and the umbilical vessels already apparent, there may be seen between the internal anterior part of the Wolffian bodies and the aorta at the origin of the omphalo-mesenteric arteries, and also around the omphalo-mesenteric vein, where that vessel is passing forward into the liver, a mass of blastema spread over the internal surface of the fore-part of the Wolffian body, and arranged in one or more masses between that gland and the aorta.

In embryos rather more advanced, these masses of blastema become less distinct, apparently from their increased bulk causing them to be applied more uniformly over the anterior extremities of the Wolffian bodies. They may always be detected by their whiter appearance, and by being destitute of the cross markings produced by the ducts of the Wolffian glands.

It is not till the testes, ovaries and kidneys have appeared, that the supra-renal capsules are recognized as distinct organs; and their progress after this period need not be considered further at present.

The cardinal veins of Rathke pass forward along the posterior and lateral part of the Wolffian bodies; after passing beyond the blunt anterior extremities of these bodies, each vein carries with it, or is covered by a thin layer of the blastema already alluded to, as forming at its posterior part the supra-renal capsule. This portion of the blastema becomes much larger at the side of the heart, round the ductus Cuvieri, behind the lateral parts of the pericardium, and in the future situation of the lungs, which have not yet left their median position. Each lateral portion of the blastema stretches

Transpiration of mixed Gases



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from the heart forwards along the internal side of the jugular vein, par vagum and carotid arteries. These two anterior portions of the lateral blastema, from the narrow portion forwards to the skull, are the lateral portions of the thymus and thyroid, which have not yet joined across the middle line.

In embryos a little further advanced, the two portions of blastema join across the trachea in a line extending from the base of the heart to the lower end of the larynx, which has now appeared as an oblong oval swelling behind the tongue. Previous to, and also contemporaneous with this cross junction, a change has occurred in the position of the lungs and of the ductus Cuvieri.

As the lungs proceed in development, they pass in a direction from behind forwards and from within outwards, moving from their original median position to a lateral one: they at the same time increase both absolutely and relatively. At the same time, a somewhat similar change takes place in the two ductus Cuvieri. They pass forward so as to appear to enter the anterior instead of the posterior extremity of the auricle, becoming in this way the anterior venæ cavæ, this change of position being produced apparently by a semi-revolution of the whole heart, coinciding with its elongation and the altered arrangement of the bulbus aortæ.

Coincident with this change in the ductus Cuvieri is a corresponding change in the position of the lateral masses of the blastema. These pass forward, become grouped around the auricles and anterior venæ cavæ, and join across the middle line as already stated; but a narrow portion, particularly along the left side, still passes downwards and backwards along the cardinal veins, which have now become the azygos veins.

While these changes in the veins and blastema have taken place, the lungs have increased in size, and their roots have taken up their proper position. In consequence of this change in the position of the pulmonary roots and of the ductus Cuvieri, the cardinal veins arch over the root of the lungs in the same manner as the azygos vein of the adult does.

At the same time the blastema of opposite sides unites, as has been stated, across and in front of the base of the heart and root of the neck.

Shortly after this period, the posterior part of the blastema, which has now advanced, as already stated, from the sides of the chest to the front of the heart, becomes separated by a narrow neck from the cervical portion. The posterior part has now become the thoracic portion of the thymus, and in the embryo of the Sheep is largest on the left side, corresponding in this respect to the large size of the left vena azygos and left vena cava at this period.

The cervical portion of the blastema now begins to exhibit a separation into the thyroid and cervical portion of the thymus. This is effected by the absorption of a portion of the blastema, of a triangular form, a little behind the larynx, the apex looking backwards, the concave base forwards, so that the future thyroid present a

crescentic form, its sides being as yet united to the anterior horns of the thymus, which pass along the jugular veins.

The thyroid now separates more completely from the thymus, by the prolongation forwards of the absorption previously mentioned from the anterior angles of the triangular portion, so as to separate the thyroid from the anterior horns of the thymus; at the same time the posterior angle of the absorbed portion passing back so as almost again to separate the cervical portion of the thymus into two lateral portions.

As development advances the thyroid becomes more completely separated from the thymus, and the lateral portions of the cervical part of the latter are united only by the narrow portion which connects them with the thoracic lobe of the organ.

At this stage a distinction may be observed, with low magnifying power, in the texture of the two organs. The thyroid is more opake and homogeneous, the thymus consists of minute granular masses imbedded in a semitransparent matrix. The component elements of the texture of the two organs is however identical, namely, simple nucleated cells grouped around dark points, which I am inclined to regard as centres of nutrition. In the thyroid, these groups are separated and connected by a more or less dense highly vascular areolar texture. In the thymus this texture is weak or deficient.

After this period no great change occurs in the thyroid and thymus of the Sheep; the anterior extremities of the horns of the thymus on each side presenting two bulbous enlargements near the base of the skull, close to the ganglions of the vagus.

Four minute white cords may now be seen passing into the superior, and two into the inferior border of the thyroid. These are the inferior and superior thyroid arteries, branches respectively from the first and second branchial arteries.

From these observations it would appear that the supra-renal capsules, the thymus and thyroid, are persistent portions of the membrana intermedia of the germinal area of the ovum, retaining throughout their existence their original simple cellular constitution of that portion of the germinal membrane.

I shall now endeavour to explain in how far the observations just detailed appear to me to enable us to trace the functional import and anatomical peculiarities of these organs.

During the first stage of the development of the animal ovum, digestion and respiration—the absorption and preparation of nutriment—are carried on by the blastoderma, a structure consisting of nucleated cells and of vessels.

The cells, of which the blastoderma consists, are the progeny of that previously occupying the germinal spot of the ovum, and are continually reproduced and increased in numbers by the production of others from the nutritive centres, or secondary germinal spots distributed over it.

Materials for the nutrition of the blastoderma are derived from the subjacent yelk. The matter resulting from the solution of a certain number of the secondary

blastodermal cells, that is, of the progeny of the primary blastodermal cells, or *nutritive centres*, is employed by the nutrient matter of the remaining secondary or proper blastodermal cells. In this way "pabulum" is afforded for two purposes, the growth of the blastoderma, and the growth of the embryo itself.

During the early period of the existence of the blastoderma, before the circulation has been established, the product of solution of the elder is at once absorbed by the younger cells. During the later periods, the product of solution drops into the incipient loops of the blood-vessels, and so circulates for purposes of nutrition. This is an instance of primary lymphatic absorption, and differs in no essential particular from the same process in the animal further advanced. We may consider the blastoderma in fact, during the first period of its circulation, as containing very numerous lymphatic ducts, instead of a few, as in the more perfect animal.

In the blastoderma, the process by which nutrient matter passes into the circulation, or the act of absorption, as it is usually called, is reduced to its most simple form, being contemporaneous and also identical with the formation of the imperfect capillary network. In the more advanced animal, when the capillary network is consolidated, the product of solution of the textures passes or drops into the intercellular or textural lacunæ, which appear to be the radicles of the lymphatic system; a system which in the adult communicates with the blood-vessels only at a few places in the neighbourhood of the trunks of the original blastodermal veins.

The blastoderma may be considered therefore not only as the first form which the being assumes after the commencement of development, and as a basis out of, and in which its higher structures are to be raised, but also, as has been already stated, the organ of primary digestion; that is, of the appropriation and elaboration by the individual of nutritive matter already prepared, to a certain extent, by another individual or organ.

All the principal organs and parts of the future being are formed in, and out of, portions of the blastoderma. The laminæ dorsales, the cerebro-spinal axis, the visceral laminæ, the intestinal tube, heart and liver, derive their origin from this source. Their original relation to this part is soon lost sight of from changes in their positions, but principally from the increased development of their original blastema, and its change into the various textures, and from the various arrangement of these textures in the organs.

There are three organs however which still retain their primitive structure after all the other parts of the animal have undergone their complete development, so as finally to exhibit no trace of their original simple texture and arrangement. These organs are the supra-renal capsules, the thymus and thyroid.

The structure of each of these three organs is essentially the same: they consist of masses of nucleated cells. These cells are grouped around numerous germinal spots, arranged throughout the mass, and which may be supposed to act as centres of origin and of nutrition, each for its own group. The mass of the organ is supplied

with blood-vessels to convey the blood to and from the part, and with lymphatics which receive the product of solution of the cells, and convey it back again into the general circulation, whence it was originally derived.

The account of the structure of the thymus given by Sir ASTLEY COOPER, is so far incorrect, as this organ contains no reservoirs or cavities in its substance. The cavities exhibited by Sir ASTLEY COOPER in his drawings and preparations, are the results of modes of preparing. They are artificial cavities formed by distension, between the somewhat smooth, highly vascular, and slightly adhering outer surfaces of contiguous lobules; the whole organ being at the same time bound together by a stronger external areolar texture. No milky fluid is found naturally in these interlobular spaces. Indeed Sir ASTLEY COOPER says, that "the best mode of obtaining it, is by cutting the gland into very small pieces and placing them upon gauze, which being squeezed, the solid is separated from the fluid part, and the latter escapes through the gauze."

The thymus, from the time it assumes its most perfect structure till it begins to degenerate into fatty substance, consists of lobes connected by areolar fibres, without cavities or ducts, formed of nucleated cells grouped around germinal spots, deriving matter for the formation of their cells from arteries passing into it, and being relieved of its venous blood by returning veins, being plentifully supplied with lymphatics, which do not communicate with the supposed reservoirs, as has been suggested, but appear to take their origin, as in other parts, by intercellular lacunæ, in which the walls seem gradually to lose themselves, as the ducts of the liver are lost among the secreting cells of that organ.

The thyroid body possesses a structure which is essentially the same as that of the thymus. It differs from the thymus in not being divided into lobules, in having the groups of cells of which it consists separated from one another by moderately strong capsular membranes, and in being more vascular, the anterior and venous trunks being much larger.

The supra-renal capsules also consist of nucleated cells grouped round germinal spots, and arranged, not in lobules, but in columns passing towards the surface of the organs; an arrangement corresponding to the radiating direction of the veins, and the converging arteries of these parts. The supra-renal and thyroid bodies are more vascular than the thymus from being developed around large arteries, while the thymus is in connection with smaller trunks, the former being developed in connection with the first and second aortic arches and the omphalo-mesenteric vessels; the latter in connexion with the internal mammary arteries and other small thoracic and cervical branches. The greater density of the areolar capsule of the thyroid may probably be explained by this increased vascular supply.

That portion of the membrana intermedia which is separated from the rest of the membrane, and included in the body of the embryo by the umbilical constriction, and which has not already been devoted to the formation of the heart, liver, pancreas

and external portion of the intestinal canal, is found massed along the trunks of the primitive venous system, the sides of the arches of the aorta, the terminal portion of that vessel, and the origins of the omphalo-mesenteric arteries.

The portions of the membrana intermedia which are last of being converted into special organs, the Wolffian bodies, are the parts which project one on each side of the aorta, along the posterior part of the cardinal veins of RATHKE, between the intestinal plates and visceral laminæ.

The portions of the membrana intermedia which remain between the upper extremities of the Wolffian bodies, and the heart and liver, and which surround the origins of the omphalo-mesenteric arteries, do not become converted into organs of special structure, but retain during life the original constitution of the membrana intermedia of the blastoderma, and increase rapidly in the embryo, constituting the supra-renal capsules. Whatever doubt may be entertained as to the exact functional import of these bodies, the identity of their anatomical constitution with that of the blastoderma is sufficiently evident, and their morphological signification appears to be equally so.

That portion of the membrana intermedia which is situated between those two aortic arches, the extremities of which become the carotid and subclavian arteries, remains during life as the thyroid body. It receives its blood from the first and second aortic arches by two large trunks on each side, the superior and inferior thyroid arteries.

That portion of the membrane which passes in two parts from near the base of the cranium back as far as the ductus Cuvieri and anterior portions of the veins of RATHKE, and which are united and concentrated in front of the heart by passing from behind forwards, in harmony with corresponding motions of the neighbouring part, becomes the thymus.

The structure of these three organs is identical with that of the blastoderma. Their probable function, namely, to prepare by the action of their nucleated cells, and to throw into the vascular system a matter necessary for the nutrition of the animal during the period of its active growth—a function which the observations and opinions of the majority of physiologists have assigned to them—is also essentially the same with that of the blastoderma.

The question as to the exact or intimate nature of the function of these organs can only be answered by further inquiries in chemical physiology. It appears to me to be sufficient at present to insist, that their functions, as deduced from their structure and anatomical relations, is similar to that performed by the blastoderma, whatever the exact nature of that function may be.

I have therefore been led to consider the supra-renal capsules, the thymus and thyroid, as organs essentially similar in structure; as developments of the remains of the blastoderma, being formed of a continuous portion of that part situated along each side of the spine, from the Wolffian bodies to the base of the cranium, the supra-

renal capsules being developed in connection with the omphalo-mesenteric vessels, the thymus to the jugular and cardinal veins, and ductus Cuvieri; and the thyroid to the anastomosing branches of the first and second aortic arches, as organs performing functions, whatever these may be, analogous to those of the blastoderma, differing from them only in this, that the blastoderma not only elaborates nourishment for the embryo, but absorbs it also from without, that is, from the yelk; whereas the three organs in question only elaborate the matter which has already been absorbed by the other parts, and is now circulating in the vessels of the more perfect individual.

Description of the Plate.

PLATE XXXVI.

Fig. 1. A portion of an early embryo of the Sheep.

a. Heart.
b. Lungs still in front of the intestinal tube.
c. Wolffian body.
d. Lateral mass of blastema, out of which is formed the supra-renal capsule, thymus and thyroid.
e. Cardinal vein.
f. Jugular vein.
g. Ductus Cuvieri.

Fig. 2. A portion of the early embryo of the Sheep.

a. Intestinal tube and ductus vitelli.
b. Liver.
c. Omphalo-mesenteric vein.
d. Omphalo-mesenteric artery.
e.f. Mass of blastema on the inner side of the Wolffian body, and around the trunks of the omphalo-mesenteric vessels; this is the posterior part of the lateral mass of blastema marked *d* in fig. 1, and becomes in the course of development the supra-renal capsule.

Fig. 3. An early embryo of the Sheep.

a. Head, branchial arches, and rudiment of the eye.
b. Heart.
c. Ductus Cuvieri entering the auricle, and receiving
d. The jugular, and
e. The cardinal vein.
f. The lateral blastema.
g. Wolffian body.
h. Umbilical cord, to which is passing

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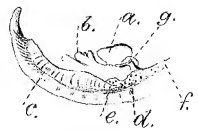

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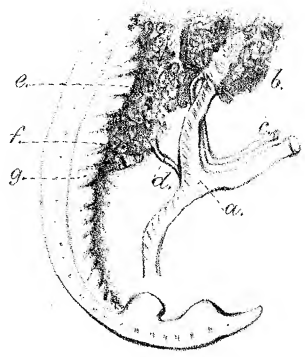

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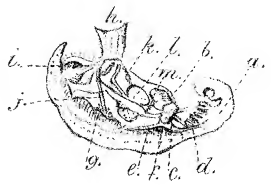

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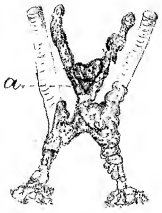

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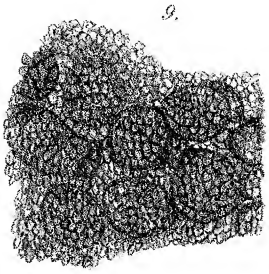

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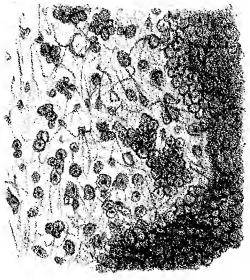

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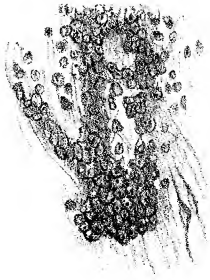

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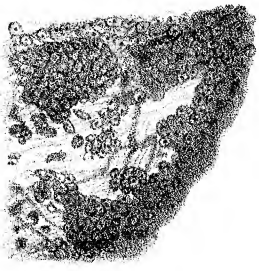

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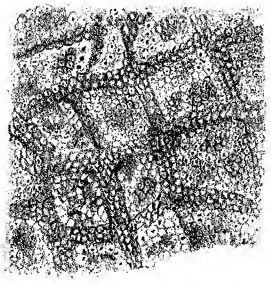

i. The allantois,

j. The omphalo-mesenteric artery, and

k. Omphalo-mesenteric vein; traces of the umbilical vessels are also seen in the parietes of the abdomen.

l. The liver and intestinal tube.

m. Lungs.

Fig. 4. Jugular veins and lateral masses of blastema in the Sheep, soon after the latter have joined across the middle line.

a. The triangular absorption of the cervical portion, which is the first indication of the separation of the thyroid.

Fig. 5. The next stage, in which the thyroid is more distinct.

Fig. 6. The thyroid is now quite distinct and differs from the thymus in being opake; the latter exhibits opake spots in a semitransparent matrix.

Fig. 7. The thyroid and thymus have assumed their perfect form.

Fig. 8. A portion of the supra-renal capsule of the adult green Monkey, slightly compressed. It exhibits the minute nucleated particles of which it consists. Among these, at pretty regular distances, are seen the germinal spots.

Fig. 9. A portion of the thymus of the Brown Bear, slightly compressed. It exhibits the nucleated particles of which it consists. These are grouped in spherical masses around centres from which they appear to have derived their origin.

Fig. 10. A portion of the thymus from a human fœtus. It has been taken from the surface of the gland, so as to exhibit the areolar fibres which form its delicate capsule. The pressure of the glass plates has almost obliterated the spherical grouping of the cells.

Fig. 11. A portion of the membrane which covered the contiguous surfaces of the lobes of the thymus of a human fœtus (the membrane lining the reservoirs of Sir A. Cooper). It has the same structure as in fig. 10. It exhibits no germinal membrane, but consists of an areolar or fibrous texture intermixed with the cells of the organ, the fibres being more fasciculated, and running a straighter course than in the substance of the organ.

Fig. 12. A portion of the thyroid from a human fœtus, slightly compressed. It exhibits the same structure as the thymus, but its fibrous texture is more developed.

Fig. 13. A portion of the same thyroid to show its vascular net-work, in the meshes of which, as in fig. 12, the cells are seen arranged in groups.